इंटरनेट मानक

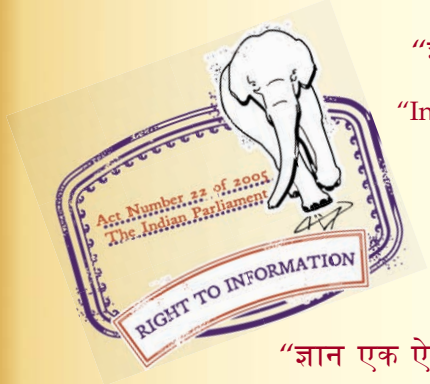
Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 11298-2 (1999): Plastic films for electrical purposes, Part 2: Methods of test [ETD 2: Solid Electrical Insulating Materials and Insulation Systems]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

IS 11298 (Part 2) : 1999
IEC 674-2 (1988)
(Reaffirmed 2004)

भारतीय मानक

विद्युत प्रयोजनों के लिए प्लास्टिक फिल्म

भाग 2 परीक्षण पद्धति

(पहला पुनरीक्षण)

Indian Standard

PLASTIC FILMS FOR ELECTRICAL PURPOSES

PART 2 METHODS OF TEST

(First Revision)

ICS 29.035.020.83.140.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 1999

Price Group 10

NATIONAL FOREWORD

This Indian Standard (Part 2) (First Revision) which is identical with IEC 674-2 (1988) 'Specification for plastic films for electrical purposes — Part 2 : Methods of test' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Solid Electrical Insulating Materials Sectional Committee (ETD 02) and approval of the Electrotechnical Division Council.

This revision has been undertaken to align this standard with IEC 674-2 (1988).

This standard (Part 2) is one of the series of Indian Standards which deals with plastic films for electrical purpose. The series consists of the following parts:

Part 1 Definitions and general requirements

Part 2 Methods of test

Part 3 Individual materials — Specifications

This standard is applicable to plastic films used for electrical purposes. This Part 2 gives 'Methods of Test'.

In this adopted standard the following International Standards are referred to. Read in their respective places the following:

International Standard	*Indian Standard*
IEC 93 (1980)	IS 3396 : 1979
IEC 243 (1967)	IS 2584 : 1963
IEC 250 (1969)	IS 4486 : 1967
IEC 394-2 (1972)	IS 11297 (Part 2) : 1988
IEC 426 (1973)	IS 8516 : 1977
IEC 454-2 (1974)	IS 7809 (Part 2) : 1986
IEC 589 (1977)	IS 10581 : 1983
IEC 674-1 : 1980	11298 (Part 1) : 1985
IEC 757: 1983	There is no equivalant Indian Standard at present

Corrigendum issued to IEC 674-2 (1988) has been printed at the end.

Only the English language text in the IEC standard has been retained while adopting it in this Indian Standard.

Certain conventions appearing in this dual number standard are not identical to those used in Indian Standards. Attention is particularly drawn to the following.

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PLASTIC FILMS FOR ELECTRICAL PURPOSES

PART 2 METHODS OF TEST

(First Revision)

INTRODUCTION

This standard is one of a series which deals with plastic films for electrical purposes.

The series will consist of three parts:

Part 1: Definitions and general requirements (IEC Publication 674-1).

Part 2: Methods of test.

Part 3: Specifications for individual materials (IEC Publication 674-3).

1. Scope

This standard is applicable to plastic films used for electrical purposes. This Part 2 gives methods of test.

2. General notes on tests

2.1 Discard at least the first three layers of film from the roll to be tested before removing test specimens.

2.2 Sample rolls shall be exposed for at least 24 h to the standard atmosphere 23 ± 2 °C and 50 ± 5% r.h. before test specimens are removed for test. Unless otherwise specified, all individual test specimens shall be conditioned for 1 h and tested in the same standard atmosphere.

3. Thickness

Thickness shall be measured by any one or more of the methods given below as required by the future IEC Publication 674-3.

3.1 *Determination of thickness by mechanical scanning*

3.1.1 *Principle*

The method is based on ISO Standard 4593 using a precision micrometer to measure the thickness of a single sheet test specimen.

3.1.2 *Test specimens and measuring points*

Cut three strips about 100 mm wide across the width of the sample. The test strips shall not contain creases or other defects.

Determine the thickness of the test strips in accordance with the requirements of ISO Standard 4593 using a micrometer having plane or radiused measuring surfaces.

Measurements shall be made at nine points at approximately equally spaced intervals along the length of the test strips. In the case of samples less than 300 mm wide make the measurements every 50 mm along the length of the test strips. In the case of untrimmed rolls, readings shall not be taken within 50 mm of the edges.

3.1.3 *Result*

The thickness is the central value of all the measurements, the highest and lowest values on each strip being reported.

3.2 *Determination of gravimetric thickness of a sample*

Principle: calculation of the thickness of a sample from measurements of mass, area and density in accordance with Section one of ISO Standard 4591.

3.3 *Determination of average gravimetric thickness of a roll*

Principle: calculation of the average thickness from measurements of the length, average width and net mass of the roll and the density of the film in accordance with Section two of ISO Standard 4591.

3.4 *Crosswise thickness profile and lengthwise variation in thickness* (Under consideration.)

4. Density

To be determined in accordance with ISO Recommendation 1183. The particular method will be specified in IEC Publication 674-3.

5. Width

To be determined in accordance with ISO Standard 4592, except that a 5 m sample length is used. Determine the width five times along the length at equal intervals after the film has relaxed for one hour.

Record each width measured and report the central value as the width of the roll.

6. Windability (bias/camber and sag)

6.1 *Principle*

An assessment is made of the distortion of the film as supplied in the roll.

Two forms of distortion may be apparent in the film which can impair its subsequent winding characteristics. These distortions are:

1) the film may exhibit bias or camber and therefore its edges may not be straight (see Figure 1, page 22);
2) the film may sag below its general level in areas where it has been stretched (see Figures 2 and 3, pages 23 and 24).

6.2 *Introduction*

Two methods are given. Method A is appropriate for narrow (i.e. less than 150 mm) films where distortion is apparent mainly as bias/camber and also for the measurement of sag for very thick films where the tension required for extension by Method B is excessive.

Method B is appropriate for wider (i.e. greater than 150 mm) films where distortion is apparent, mainly as sag.

6.3 *Method A*

6.3.1 *Principle*

To assess bias/camber, a length of film is unwound and laid on a flat surface and the deviation of each of its edges from a straight-line is measured (see Figure 1, page 22).

To assess sag, a length of film is unwound and laid orthogonally over two parallel bars under defined conditions and the deviation from a uniform catenary is measured (see Figure 2, page 23). It may sometimes be convenient to make this measurement using the rollers of a winding machine, but in cases of dispute the dimensions and distances shall be as given below.

6.3.2 *Measurement of bias/camber*

6.3.2.1 *Apparatus*

A flat, horizontal table of any suitable material having a satin finish (not polished) of sufficient width to accommodate the maximum width of film to be tested and of length 1 500 ± 15 mm with ends parallel to within 0.1° (or 1.8 mm per 1 metre of table width). Alternatively, the table may be longer than the above length but must then have two reference lines clearly marked on its surface 1 500 ± 15 mm apart and parallel to the same accuracy.

- A soft brush suitable for smoothing the film specimen on the table surface.
- A long (in excess of 1 525 mm) steel straight-edge.
- A 150 mm steel rule with 1 mm graduations.

6.3.2.2 *Test specimens*

The first three layers of film from the roll are discarded. For each specimen a fresh length of approximately 2 m is taken, being drawn from the roll with the lightest tension necessary to unwind it slowly (at about 300 mm/s).

6.3.2.3 *Procedure*

The specimen length of film is placed lengthwise over the table as shown in Figure 1. Starting from one end, the soft brush is used to lightly press the film into intimate contact with the table surface, expelling any trapped air as far as possible.

The steel straight-edge is then placed along one edge of the film so that any deviation of the film edge from a straight line can be readily observed. The straight-edge is adjusted to coincide with the film edge at the two table ends (or at the reference marks if these are used) and the distance between these points shall be 1 500 ± 15 mm. The distance between the straight edge and the film edge is measured to the nearest 1 mm at approximately mid-span by means of the steel rule.

The deviation of the second film edge is then measured using the same procedure.

The sum of the distances in millimetres of the two edges of the film from the steel straight-edge at the mid-span is the bias/camber value for that test specimen.

The above procedure is repeated for two further test specimens.

6.3.2.4 *Results*

The bias/camber is the central value of the three determinations, the other two values being reported.

6.3.3 *Measurement of sag*

6.3.3.1 *Apparatus*

A rigid framework supporting two parallel, freely rotatable metal rollers, each roller 100 ± 10 mm in diameter and of sufficient length to accommodate the maximum width of film to be tested. The axes of the rollers shall be in the same horizontal plane and set mutually parallel to within 0.1° (i.e. within 1.8 mm per 1 m length of roller) with a separation of 1 500 ± 15 mm. The roller surfaces shall be accurately cylindrical to within 0.1 mm with any suitable satin finish (not polished) (see Figure 2, page 23). The framework shall be fitted with a device for mounting the roll of film being tested immediately below one of the rollers. The mounting shall be such that the axis of the film roll is parallel to the superior roller to within 1° and the film may be drawn off the roll against an adjustable unwind tension. At the opposite end of the framework a weighted or sprung clamp is fixed to the film web hanging freely from the second roller. The weight or spring loading and its position on the film may be adjusted so as to give a substantially uniform tension across the web as specified in IEC Publication 674-3.

A device for measuring along a line midway between the rollers the distance of the film below the plane of those rollers (see Figure 3, page 24). The device may comprise simply a long (in excess of 1,525 mm) steel straight-edge and a 150 mm steel rule with 1 mm graduations, or more complex devices may be employed whereby the film position is noted automatically or semi-automatically.

6.3.3.2 *Test specimens*

The first three layers of film from the roll are discarded. For each specimen a fresh length of approximately 2 m is drawn from the roll with the lightest tension necessary to unwind it slowly (at about 300 mm/s).

6.3.3.3 *Procedure*

The specimen length of film is placed over the apparatus rollers. the free end of the film is clamped in the tensioning device, the tension adjusted to the value given for the film in IEC Publication 674-3 and the lateral position of the film as it passes over the second roller adjusted so that the film web lies approximately horizontal at mid-span.

Using the steel straight-edge and graduated steel ruler or other suitable device the film is checked across the film width at mid-span and any edge sag or sag lanes noted. The maximum depth of any sag lane below the general film surface surrounding it is measured to the nearest 1 mm (see Figure 3) and reported as the sag value for that test.

The above procedure is repeated for two further test specimens.

6.3.3.4 *Result*

The sag value is the central value of the three determinations, the other two values being reported.

6.4 *Method B*

6.4.1 *Principle*

The total amount of sag and bias/camber is assessed by one measurement. A length of film is unwound and laid orthogonally over two parallel bars under defined conditions. The film is strained until free of visible sag and bias/camber and the extension necessary to achieve this is

measured. It may sometimes be convenient to make this measurement using the rollers of a winding machine but in cases of dispute the dimensions and distances shall be as given below.

6.4.2 *Apparatus*

A rigid framework supporting two parallel, freely-rotatable metal rollers, each roller 100 ± 10 mm in diameter and of sufficient length to accommodate the maximum width of film to be tested. The axes of the rollers shall be in the same horizontal plane and set mutually parallel to within 0.1° (i.e. within 1.8 mm per 1 m length of roller) with a separation of 1.500 ± 15 mm. The roller surfaces shall be accurately cylindrical to within ± 0.1 mm with any suitable satin finish (not polished). The framework shall be fitted with a device for mounting the roll of film being tested immediately below one of the rollers. The mounting shall be such that:

a) the axis of the film roll is parallel to the superior roller to within 2°;

b) the lateral position of the film may be adjusted as desired, and

c) the film may be drawn off the roll against an adjustable unwind tension.

At the opposite end of the framework a weighted or sprung clamp is fixed to the film web hanging freely from the second roller. The weight or spring loading of the clamp and its position on the film may be varied to give an adjustable tension substantially uniform across the web.

- A steel straight-edge (in excess of 1 525 mm).
- A flexible steel rule 2 m or more in length with 1 mm graduations.
- Suitable self-adhesive labels.

6.4.3 *Test specimens*

The first three layers of film from the roll are discarded and a fresh length of approximately 2 m is drawn from the roll with the lightest tension necessary to unwind it slowly (at about 300 mm/s).

6.4.4 *Procedure*

The specimen length of film is placed over the apparatus rollers. With light hand tension applied to the web, the free end of the film is moved so that the film web between the rollers is as flat as possible and the free end is then clamped in the tensioning device. The tension is adjusted to 1.0 ± 0.2 MN/m^2 (based on the nominal thickness and width of the film).

Two reference marks (between 1.0 m and 1.1 m apart) are applied to the film on a line exhibiting minimal sag and which is approximately parallel to the edges of the film. These marks may conveniently be specific edges of two self-adhesive labels applied to the film surface.

The distance between the marks is measured to within ± 0.5 mm using the flexible steel tape.

The tension applied to the film is increased until:

a) the film is visually smooth;

b) each film edge is straight to within 0.5 mm at mid-span when compared with the straight-edge, and

c) the sag at any point does not exceed 7.5 mm when compared with the straight-edge.

The distance between the reference marks at this tension is measured using the steel tape and the extension of the film is expressed as a percentage of the original mark separation.

The above procedure is repeated for two further test specimens.

6.4.5 *Result*

The total sag and bias/camber is the central value of the three determinations, the other two values being reported.

7. Surface roughness

Under consideration.

8. Coefficient of friction

To be determined in accordance with IEC Publication 648.

Principle

This method covers determination of starting and sliding friction of plastic film and sheeting when sliding over itself or other substances under specified conditions. The procedure permits the use of a stationary sled with a moving plane or a moving sled with a stationary plane. Both procedures yield the surface coefficient of friction for a given test specimen.

9. Wetting tension (polyolefine films)

9.1 *Test principle and introductory remarks*

The determination of the wetting tension is based on the phenomenon that drops of a series of an organic liquid mixture with gradually increasing surface tension, when they have reached a specific concentration, have the ability to wet the film surface. Since the wetting tension of a film in contact with a drop of the respective liquid mixture in the presence of air is a function of the surface energies of both the air-film and the film-liquid interfaces, any trace of surface-active impurities in the liquid reagents or on the film may affect the results. It is, therefore, important that the film surface to be tested should not be touched or rubbed, that all equipment be clean and that reagent purity be carefully controlled.

9.2 *Apparatus*

- Cotton-tipped wooden applicators approximately 150 mm long.
- Two burets, 50 ml.
- Bottles, 100 ml with caps and labels { cleaned with chrome sulphuric acid and rinsed with distilled water.

9.3 *Reagents*

Prepare mixtures of reagent-grade formamide ($HCONH_2$) and reagent-grade ethylene-glycol-monoethyl-ether ($CH_3\ CH_2\ -O\ -CH_2\ CH_2\ -OH$) in the proportions shown in the following Table I for the integral values of wetting tension in the range over which measurements are to be made.

If desired, add to each of the mixtures mentioned in Table I a very small amount of dye of high tinctorial value. The dye used should be of such colour as to make drops clearly visible on the surface of the polyolefin film. Furthermore, the dye must be of such chemical composition that it will not measurably affect the wetting tension of the liquid mixtures.

Notes 1. — It is recommended that the surface tension of the liquid mixtures be checked weekly. Any wetting tension method usually applied in the laboratory is suitable.

2. — Although the shown liquid mixtures are relatively stable, exposure to temperatures above 30 °C and humidity above 70% r.h. should be avoided.

3. — Both ethylene-glycol-monoethyl-ether and formamide are toxic and should be handled with due precaution. Since formamide is particularly dangerous when in direct contact with the eyes, safety goggles should be worn when making up the liquid mixtures. National safety regulations should be observed.

TABLE I

Concentrations of ethylene-glycol-monoethyl-ether, formamide mixtures used in measuring wetting tension of polyethylene and polypropylene films

Formamide volume per cent	Ethylene-glycol-monoethyl-ether per cent	Wetting tension (mN/m)
0	100.0	30
2.5	97.5	31
10.5	89.5	32
19.0	81.0	33
26.5	73.5	34
35.0	65.0	35
42.5	57.5	36
48.5	51.5	37
54.0	46.0	38
59.0	41.0	39
63.5	36.5	40
67.5	32.5	41
71.5	28.5	42
74.7	25.3	43
78.0	22.0	44
80.3	19.7	45
83.0	17.0	46
87.0	13.0	48
90.7	9.3	50
93.7	6.3	52
96.3	3.7	54
99.0	1.0	56

9.4 *Test specimens*

The first three layers of film from the roll are discarded. One sample across the entire width of a roll should be tested in such a way that one determination at each location ¼, ½, ¾ of the way across the width of the film is made. If the range of these three determinations exceeds 2.0 mN/m, indicating that the polyolefin film has been unevenly treated, measurements, as described above, shall be made at three points spaced along the length of the roll (a total of nine measurements).

Extreme care must be taken to prevent the surface of the film sample from being touched or handled in the areas upon which the test is to be made.

9.5 *Conditioning*

Standard atmosphere B according to IEC Publication 212 during testing (23 °C/50% r.h.).

9.6 *Procedure*

Wet the extreme tip of a cotton applicator with one of the mixtures. Use only a minimum amount of liquid as an excess of reagent may affect the result.

Spread the liquid lightly over an area of approximately 6.5 cm^2 (~ 25 mm in diameter) of the test specimen at the selected location. Do not try to cover a larger area lest there be insufficient liquid to give complete coverage. Note the time required for the continuous liquid coverage formed on the film to break up into droplets. If the continuous liquid coverage holds for more than 2 s proceed to the next highest wetting tension mixture, but if the continuous liquid coverage breaks into droplets in less than 2 s proceed to the next lowest wetting tension mixture. A clean, new cotton applicator must be used each time to avoid contamination of the solution.

Proceed in the direction indicated above continuously repeating the prescribed steps until it is possible to select the right mixture according to Sub-clause 9.7.

Experience with the test has shown that occasionally erroneous results can be obtained by working progressively to lower surface tension mixtures. Therefore, it is recommended that the tester should check the wetting tension of the film by working progressively to higher surface tension mixtures.

9.7 *Evaluation*

The mixture is considered as wetting the test specimen when it remains intact as a continuous coverage of the liquid for 2 s as close as possible. Shrinkage of the periphery of the continuous liquid coverage does not indicate lack of wetting; only breaking into droplets within 2 s indicates lack of wetting. Severe peripheral shrinking may be caused by too much liquid being placed upon the film surface. The surface tension of the applied mixture in millinewtons per metre which remains intact for 2 s is called the wetting tension of the polyolefin film test specimen.

9.8 *Report*

If one specimen has been tested and the range of results is less than 2.0 mN/m, report the central value of the three wetting tension test results.

In case of an unevenly treated polyolefin film, for which nine determinations have been made, report the central value and the individual values.

10. Tensile properties

To be determined in accordance with ISO Standard 1184.

Tensile properties generally to be specified are tensile stress and percentage elongation at break but sometimes 1% secant modulus may be specified.

10.1 *Test specimens*

Test specimens shall be in accordance with Sub-clause 6.1 of ISO Standard 1184, i.e. strips 10 mm to 25 mm wide, not less than 150 mm long, with gauge marks at least 50 mm apart.

Five specimens shall be tested in each of the directions specified in IEC Publication 674-3.

10.2 *Speed of testing*

The speed of testing is the rate of separation of the grips of the testing machine during a test and shall be the speed specified in IEC Publication 674-3.

10.3 *Result*

For each property and for each direction of test, the result is the central value of the five determinations, the highest and lowest values being reported.

11. Edge tearing resistance

To be determined in accordance with Clause 8 of IEC Publication 394-2.

11.1 *Principle*

The test specimen is inserted into an inclined slot of a fixture which is clamped to a tensile testing machine. The force needed to initiate tearing of the edge is determined.

12. Tear resistance

The tear resistance shall be determined in accordance with either Draft International Standard ISO/DIS 6824 or ISO Standard 6383/1. The method to be used will be specified in IEC Publication 674-3.

13. Stiffness of film

Principle

This test method describes a means for determining the flexibility of a material by means of a fixed angle flexometer in which the test specimen bends under its own weight. A rectangular strip of material is supported on a horizontal platform in a direction perpendicular to one edge of the platform. The strip is placed on the platform with a specified length overhanging the platform and the time taken for this overhang to fall to an angle of 41° 30′ below the horizontal is recorded.

14. Surface resistivity

To be determined according to IEC Publication 93.

15. Volume resistivity

15.1 *Method 1: Electrode method*

To be determined according to IEC Publication 93, using a guarded electrode of 25 mm diameter and an unguarded one of at least 40 mm diameter.

Determinations to be made under the conditions specified in IEC Publication 674-3 from the following:

- standard dry conditions of IEC Publication 212 (18 °C-28 °C/< 1.5% r.h.);
- standard atmosphere B of Table I of IEC Publication 212 (23 °C/50% r.h.);
- dry hot conditions selected from Table I of IEC Publication 212.

15.2 *Method 2: Method for wound capacitor dielectric films or films too thin for Method 1*

15.2.1 *Principle*

This method uses the fact that the volume resistivity ρ of a capacitor dielectric may be calculated from the time constant ($t = CR$) by the relation:

$$\rho = CR/\varepsilon \cdot \varepsilon_0$$

where:

C is in farads

R is in ohms

ρ is in ohms metres

ε is the permittivity

ε_0 is equal to 8.85×10^{-12} F · m^{-1}

15.2.2 *Test specimens*

Each test specimen is a wound capacitor on a rigid insulating core, of extended foil construction, with an active electrode width of 40 mm to 70 mm and an edge margin of 3 mm. The dielectric is a single layer of the film under test and the capacitance (measured at 1 kHz) is 0.5 ± 0.1 µF. If preliminary heat or vacuum treatment is required, this will be indicated in IEC Publication 674-3.

15.2.3 *Procedure*

Three test specimens are wound as above and subjected to any necessary treatment. After further conditioning for 6 h in standard dry conditions (18-28 °C and < 1.5% r.h.) the two-minute resistance (100 ± 10 V or 25 ± 4 V/µm for films of thickness 4 µm or less) is measured and then the capacitance at a frequency below 1.6 kHz.

The permittivity is measured as indicated in Clause 16. Alternatively the theoretical value may be sufficiently accurate.

The values of ρ are calculated from the equation:

$$\rho = CR/\varepsilon \cdot \varepsilon_0$$

15.2.4 *Result*

The volume resistivity is the central value of the three measurements. The report should state the temperature of measurement and whether the permittivity was measured or assumed.

Note. — In order to reduce the error caused by the charging current of the capacitor to acceptable proportions, it is necessary for the time constant of the capacitance C of the test specimen and the input resistance r of the current measuring device to be small compared to both the time of application of voltage and the time constant of decay of the apparent leakage current. Where the application time is 2 min the Cr value should be less than 2 s for most films. Where the test specimen is 0.5 µF, the value of r should be less than 4 MΩ.

Some direct reading megohmmeters may not be satisfactory in this respect.

16. Dissipation factor and permittivity

Two methods are available:

16.1 *Method 1*

The test shall be carried out in accordance with IEC Publication 250 at a frequency to be agreed between purchaser and supplier and at a temperature of 23 ± 2 °C, the precise temperature being reported.

16.2 *Method 2*

The dissipation factor and permittivity shall be determined on a wound capacitor at a frequency of less than 1 600 Hz and at a temperature of 23 ± 2 °C, the precise temperature being reported.

For materials of dissipation factor lower than 5×10^{-4} certain precautions are necessary.

By agreement between supplier and purchaser for materials having dissipation factors below 5×10^{-4}, a capacitor construction may be used incorporating the following features:

1) The capacitor is wound on a large mandrel, removed and pressed so that varying pressure does not alter the dissipation factor.
2) The extension of foil at each end must be sufficient to allow heavy bolted connections.
3) Before the capacitor is finally clamped into final configuration, it should be vacuum dried for 3 h to 4 h at room temperature to remove absorbed moisture.

17. Dissipation factor under impregnated conditions

This standard gives no requirement for this test. The details of this test will be a matter of contract.

18. Electric strength

18.1 *A.C. test*

To be tested according to IEC Publication 243, in oil, using electrodes as indicated in Sub-clause 6.1.1 and with voltage application as indicated in Sub-clause 7.1.

18.2 *D.C. test*

Unless otherwise specified in IEC Publication 674-3, test capacitors are wound as for Sub-clause 15.2 but with an edge margin of 1 mm/kV of expected breakdown voltage. Each is subjected to an increasing direct voltage by means of a charging current of 100 ± 20 μA.

The maximum value of voltage reached is indicated and preferably retained by an indicator capable of indicating within an error less than 1% of the full-scale deflection at the rate of rise specified. This may conveniently take the form of a voltage divider feeding a self-balancing recording instrument.

Twenty-one tests are made. Report the central value of the twenty-one results and the number of breakdowns which occur at or below the voltage given in IEC Publication 674-3.

19. Electrical weak spots

The methods given involve the counting of weak spots. In interpreting the result of these counts it is important to be aware of the statistics involved. Experience has shown that the number of counts follow the Poisson type distribution law. When selecting limits for use in IEC Publication 674-3 due attention will be paid to the different statistical treatments required by tests which use a count as a result rather than measured magnitudes.

19.1 *Method A: Testing narrow strips of film in long lengths*

19.1.1 *Test equipment*

The test equipment is shown in a schematic diagram (Figure 4, page 25). It must allow the strip of film to be tested to be drawn at a constant rate of 5 m/min at a circumferential angle of approximately 90° over a reliably earthed and readily rotatable roller which serves as one of the two electrodes. The roller has a diameter of 15 mm and is of corrosion-resistant steel with a polished surface. The second electrode is a soft aluminium foil with a width of 10 mm to 20 mm and a thickness of 0.006 mm. The aluminium foil curves around the roller at the smallest possible angle (approximately 10°) and is loaded with about 40 g for each 10 mm width of the aluminium foil, preferably by a weight in the form of a clip. This presses the aluminium foil close to the strip of film to be tested. The aluminium foil must be narrower than the strip of film to be tested and arranged so that the strip of film overlaps beyond the aluminium foil by at least 2.5 mm on both sides. A direct voltage of 100 V per 0.001 mm thickness of the film to be tested shall be applied between the aluminium foil and the roller. It must be possible for the test voltage to be set whilst the strip of film is running. (The voltage set when the strip of film is motionless drops if the strip of film is moved, due to the removal of charge by the strip of film.)

The apparatus for producing the direct current must be designed so that the full test voltage is reached again after about 0.1 s following a breakdown, so that faults following each other closely can be detected. A suitable counting mechanism shall be used for counting the electrical impulses (weak spots).

19.1.2 *Procedure*

The strip of film to be tested is drawn between the roller and the aluminium foil as described in Sub-clause 19.1.1, and the electrical impulses (weak spots) counted.

19.1.3 *Results*

The weak spots counted are divided by the tested area and stated as the fault count per m^2 by method A.

The following particulars shall be stated:

- width in millimetres of the aluminium foil;
- length in metres of the tested strips of film.

19.2 *Method B: Testing wide strips of film*

Hazard note: The energy stored in this test specimen may be approximately 1 J.

19.2.1 *Test equipment*

A schematic diagram of the test equipment is given in Figure 5, page 25. On an electric insulating support of approximately 270 mm × 160 mm lies a metallized plastic foil* measuring 250 mm × 140 mm with the metal covering uppermost. A test specimen measuring 180 mm × 180 mm taken from the film to be tested is placed on the metal covering so that it overlaps by 20 mm on each of the 250 mm long sides of the metallized plastic foil and terminates at one of the 140 mm long sides of the foil. Another metallized plastic foil 140 mm wide is placed on the test specimen with the metal covering side downwards and on top of this a soft rubber sheet measuring 140 mm × 140 mm and about 4 mm thick. After folding the upper metallized plastic foil round the soft rubber sheet, the whole is loaded with a metal plate measuring

* For example, a 0.03 mm thick polyethyleneterephthalate (PETP) film vacuum metallized with aluminium.

140 mm × 140 mm weighing approximately 650 g. The test voltage is applied to the metal plate. The free end of the metallized plastic foil lying underneath is connected to earth. The test voltage (d.c. or peak a.c.) is 100 V per 0.001 mm thickness of the test specimen.

19.2.2 *Procedure*

Starting at nil, the test voltage is increased at 0.5 kV/s to the calculated value and then maintained at this calculated value for 1 min, after which the specimen is removed from the test equipment and the number of weak spots, which are recognizable by their brownish specks, are counted on an area of 100 cm^2 which is at least 20 mm from the edge of the tested area.

The testing is carried out on 10 test specimens taken from and evenly distributed over the width of the roll of film.

19.2.3 *Results*

The number of weak spots determined on the 10 test specimens is divided by the film area and stated as the fault count per square meter by method B. The type of test voltage must also be stated.

19.3 *Method C: Testing of film in rolls*

19.3.1 *Apparatus*

19.3.1.1 *Unreeling system*

A diagram of the apparatus is given in Figure 6, page 26. The film under test is unreeled at the same speed as two aluminium foil electrodes 1 and 2 by two rubber-covered rollers R4 and R5. The thickness of these electrodes is 5 to 6 µm, and electrode 1 is narrower than electrode 2 by about 20 mm; they are electrically connected to the fault measuring system by the two metal rollers R1 and R2 respectively. Fault detection takes place on the quartz roller R3, which has a diameter of 24 mm. The aluminium foil electrode 1 is tangential to this roller, while electrode 2 passes round it through 180°, so that the film under test is only subjected to the test voltage at the line of contact.

The complete unreeling system is housed in a suitable cabinet to protect it against dust. A switch is provided to cut off the test voltage whenever the door of the cabinet is opened.

19.3.1.2 *Fault counter*

The counting system comprises:

- A d.c. generator which can supply an adjustable voltage. The breakdown current is limited to a 10 kΩ resistor, irrespective of the test voltage. When breakdown occurs, the voltage should return to its initial value in less than 0.5 s.
- A suitable pulse counter, capable of counting at least 3 pulses per second.
- Optionally, a time-switch to stop the apparatus once a given length of film has been tested.

19.3.2 *Procedure*

- Adjust unreeling speed to 2 m/min;
- adjust the voltage to the value given in IEC Publication 674-3 (usually 315 V/µm of thickness of the film under test);

- pass 10 m^2 of film between the electrodes unless another area is specified in IEC Publication 674-3;
- note counter reading.

19.3.3 *Results*

The number of faults is divided by the area in square metres and expressed as the faults count per square metre by Method C.

In addition, the following shall be noted:

- width and length of the film tested;
- value of the electric field in kilovolts per millimetre or in volts per micrometre.

20. Resistance to breakdown by surface discharges

To be determined according to IEC Publication 343.

21. Electrolytic corrosion

To be determined according to one of the methods given in IEC Publication 426. The particular method will be stated in IEC Publication 674-3.

22. Melting point

(Method under consideration.)

23. Dimensional change

23.1 *Test specimens*

Cut two test specimens, measuring approximately 100 mm × 100 mm from the film. Mark each test specimen to show the machine or transverse direction. For materials narrower than 100 mm take the actual width and 100 mm length.

23.2 *Procedure*

The length and width of the test specimen are measured to an accuracy of 0.1 mm and the test specimen is then suspended free in a hot cabinet with natural circulation of air, for the period of time and at the temperature specified in IEC Publication 674-3.

After cooling to room temperature the length and the width are measured at the same points as previously.

23.3 *Results*

The changes in dimensions of each test specimen are calculated in relation to the initial dimensions as a percentage of dimensional change in the machine and transverse direction. The dimensional change in each direction is the mean value of the two determinations in that direction.

24. Dimensional stability under tension with rising temperature

24.1 *Test specimens*

Test specimens of 15 mm in width are cut from films in the machine and also, where applicable, in the transverse direction of the roll of film (care should be taken to obtain satisfactorily cut surfaces); from narrower tapes, film test specimens are taken in the delivered width. The length of the test specimens is according to the test equipment. The measured length of 20 mm is marked by two lines in approximately the middle of their length and over their entire width.

24.2 *Procedure*

The test specimen is suspended in a hot cabinet and loaded to a tension of 2.5 N/mm^2. Beyond (alongside, in the case of opaque film) the measured length of the test specimen, a scale is applied which permits the change in the measured length to be read off to within 1 mm accuracy.

A thermocouple is secured to the test specimen in the region of the measured length. The hot cabinet is heated so that the temperature measured at the temperature-measuring apparatus rises steadily by 50 ± 1 °C per hour, starting at not more than 30 °C. When the measured length has increased under load by 40%, compared with the initial length or the test specimen tears, a reading of the temperature is taken. Tests in which the specimen is torn at the grips are not evaluated and shall be repeated.

Three specimens are tested in the machine direction and, where applicable, three in the transverse direction of the roll of film.

24.3 *Results*

The central value from the three individual values of the temperature is stated as dimensional stability under tensile stress with rising temperature in the direction concerned.

It is best to plot a graph of the change in the measured length relative to the temperature. If the test specimen tears before reaching an extension of 40%, this shall be stated together with the temperature.

25. Dimensional stability under pressure with rising temperature

25.1 *Test equipment*

The specimen is held between two 1 mm diameter nickel wires which cross at an angle of 90° under a fixed load of 30 N. Penetration of the test specimen is indicated by electrical contact of the two wires.

25.2 *Test specimens*

Three test specimens 30 mm × 30 mm are cut from the film.

25.3 *Procedure*

The test equipment is placed in a vibration-free laboratory oven with air circulation, the test specimen is laid between the penetrating fins of the test equipment and loaded without shock to 30 N. A d.c. voltage of approximately 40 V is then connected via the signalling instrument to the two penetrating fins. Beginning at 30 °C, the temperature is increased every hour by 50 ± 1 °C. The temperature is measured in the immediate vicinity of the test specimen. As soon as the signalling instrument indicates destruction of the test specimen, the temperature is read.

25.4 *Results*

The central value of three individual values for the temperature is quoted in degrees Celsius as the dimensional stability under pressure and with rising temperature.

26. Resistance to penetration at elevated temperature

To be determined according to Clause 3 of IEC Publication 454-2.

26.1 *Principle*

The method determines the temperature at which a 1.5 mm diameter sphere penetrates the film so as to make electrical contact through it.

27. Volatile content (loss of mass on heating)

27.1 *Test specimens*

Three specimens are tested. Each test specimen consists of sufficient pieces of film 50 mm × 50 mm to provide a specimen of mass not less than 300 mg. In the case of film less than 50 mm width, the test specimen shall be a length of film of mass not less than 300 mg.

27.2 *Procedure*

The test specimen is dried in an oven at the pre-conditioning temperature and for the time specified in IEC Publication 674-3. During this and subsequent heating operations, the test specimen shall be arranged so as to allow free circulation of air over all surfaces.

The test specimen is then cooled to room temperature in a desiccator and weighed (m_1).

The test specimen shall then be heated at the temperature and for the time specified in IEC Pubication 674-3. It shall then be cooled to room temperature in a desiccator and weighed (m_2).

27.3 *Result*

The volatile content, in percentage, of each specimen is:

$$\frac{m_1 - m_2}{m_1} \times 100$$

The result is the central value to the three determinations, the other two values being reported.

28. Thermal endurance

Thermal endurance shall be determined in accordance with IEC Publications 216-1 and 216-2. Test methods and end-point criteria are to be specified in IEC Publication 674-3.

29. Burning characteristics

29.1 *Principle*

This is a combustion test on test specimens in vertical position with the object of dividing materials into different classes according to the results obtained.

The test is applicable to thin materials (thickness up to and including 0.25 mm), including those which shrink or distort at the side opposite the flame.

29.2 *Apparatus*

- Test chamber, enclosure or laboratory fume cupboard free from draughts;
- Bunsen or Tyrrel burner having a tube 100 mm long and an inside diameter of 9 mm;

— circular support with clips or other means of holding test specimens in a vertical position;

— supply of methane gas (technical grade) with regulator and meter to obtain a uniform rate of flow. (Natural gas having a calorific value of 9 000 kcal/m³ (1 000 BThU per cubic foot) is considered capable of giving similar results.);

— stop-watch or similar suitable device;

— absorbent surgical cotton;

— anhydrous calcium chloride desiccator;

— conditioning room or chamber at 23 ± 2 °C/50 ± 5% r.h.;

— ventilated oven at 70 ± 1 °C;

— a mandrel 9.5 ± 0.5 mm in diameter.

29.3 *Test specimens*

Five test specimens shall be tested.

The test specimens shall be cut from the film under test and shall have the following dimensions: length 200 mm, width 50 mm.

The specimens tested by this method are limited to a maximum thickness of 0.25 mm.

The test specimens shall be prepared by drawing a line across the width of the sample at 125 mm from one of its ends.

The test specimen is then wound around a mandrel of diameter 9.5 ± 0.5 mm so as to form a cylinder 200 mm long, with the line marking the length of 125 mm on its outer face.

The end of the rolled test specimen is fixed by means of an adhesive tape 75 mm wide placed with one of its edges along the 125 mm line. The cylindrical test specimen is then removed from the mandrel.

29.4 *Conditioning*

Batches of test specimens shall be conditioned as follows:

a) batches of five test specimens each, conditioned for at least 48 h at 23 ± 2 °C/50 ± 5% r.h. before the test;

b) batches of five test specimens each, conditioned before testing in a ventilated oven for 168 h at 70 ± 1 °C, and then allowed to cool for 4 h to the ambient temperature.

29.5 *Procedure*

The test shall be carried out in a room, enclosure or laboratory fume cupboard free from draughts.

A closed laboratory fume cupboard provided with a heat-resistant glass window and an extractor fan for removing combustion products after the test is recommended.

The circular support shall hold the test specimen over a length of 6.0 mm at its upper end, with its longitudinal axis vertical, and its lower end 9.5 mm above the top of the burner, and 300 mm above a horizontal layer of dry absorbent surgical cotton measuring 50 mm × 50 mm and 6.0 mm thick.

The cylindrical test specimen so placed shall have its upper end open.

The burner is then held well away from the test specimen, lit and regulated so as to obtain a blue flame 20 ± 1 mm high. This flame may be obtained by adjusting both the gas flow and air inlet to

obtain a flame 20 mm high with yellow tip, and then increasing the air until the yellow tip disappears. The height of the flame should then be remeasured and corrected if necessary.

The flame is then placed concentrically below the centre of the lower end of the specimen under test, and maintained there for 3 s.

The flame is then removed from the test specimen to a distance of at least 150 mm, and the time for which the test specimen continues to burn is noted.

When the burning has stopped, the flame is immediately replaced under the test specimen. After 3 s, the flame is again removed and the duration of flames and burning is noted.

If the test specimen emits molten or flaming matter during one of the applications of the flame, the burner should be tilted at an angle of 45° and moved slightly towards the side of the test specimen to prevent particles of such matter from falling into the burner tube.

If the test specimen burns away from the flame during the test, the burner should be held in the hand, and the distance 9.5 mm between the bottom of the test specimen and the top of the burner tube maintained during application of the flame, ignoring any threads of molten material.

During the test, the following shall be observed and noted:

a) the duration of burning with flames after the first application of the burner;

b) the duration of burning with flames after the second application of the burner;

c) whether or not the test specimen gives off flaming particles which ignite the surgical cotton;

d) the duration of any combustion after the second application of the burner;

e) whether or not the test specimen burns right up to the 125 mm mark.

29.6 *Interpretation of results*

According to the results obtained from the tests described above, the materials are classified VTF 0, VTF 1 and VTF 2 as given in the table below.

If during the tests:

— one of the 5 test specimens does not fulfil criteria A, C, D or E, or

— the total combustion time (criterion B) is exceeded by up to 5 s, a further test on a fresh batch of five test specimens is allowed.

All the test specimens submitted to this second test shall fulfil the requirements for the class into which they are classified.

Classification of materials
regarding self-extinguishing properties

Criteria		VTF 0	VTF 1	VTF 2
A	Maximum duration of burning with flames after each application of the burner	10 s	30 s	30 s
B	Maximum total combustion time for 10 applications of the burner for all 5 test specimens	50 s	250 s	250 s
C	Number of test specimens capable of burning up to the 125 mm mark	0	0	0
D	Emission of flaming particles capable of igniting the surgical cotton placed 300 mm below the test specimen	0	0	*
E	Maximum duration of combustion without flame after removing the burner for the second time	30 s	60 s	60 s

* A few flaming particles burning for a short time, some of which may ignite the surgical cotton.

30. Water absorption in a damp atmosphere

30.1 *Apparatus*

- Balance with an accuracy ± 0.1 mg;
- weighing bottles;
- oven, capable of maintaining a temperature as specified in IEC Publication 674-3;
- desiccator;
- enclosure in which a relative humidity of 93 ± 2% can be maintained.

30.2 *Test specimens*

Three specimens are tested. Each test specimen consists of sufficient pieces of film 50 mm × 50 mm to provide a test specimen of mass not less than 300 mg. In the case of film less than 50 mm width, the test specimen shall be a length of film of mass not less than 300 mg.

30.3 *Procedure*

30.3.1 *Water absorption of material as-received*

The mass of three test specimens in the as-received condition is determined.

These pieces are placed in an atmosphere of 93 ± 2% r.h. for a period of time to be specified in IEC Publication 674-3 and selected from Table III of IEC Publication 212. After this period of time has elapsed, the mass (to the nearest mg) of each test specimen is determined immediately in a closed weighing bottle. The increase in mass of each test specimen is calculated.

30.3.2 *Water absorption of dry material*

Three test specimens are dried in an oven at the temperature given in IEC Publication 674-3 for a period of 24 h and then cooled to room temperature in a desiccator over phosphorus pentoxide for at least 1 h. Each of the test specimens is weighed in a closed weighing bottle (to the nearest mg).

These test specimens are placed in an atmosphere of 93 ± 2% r.h. for a period of time to be specified in IEC Publication 674-3 and selected from Table III of IEC Publication 212. After this period of time has elapsed the mass (to the nearest mg) of each test specimen is determined immediately in a closed weighing bottle. The increase in mass of each test specimen is calculated.

30.4 *Results*

Take the central value of the three determinations and report the increase in mass as a percentage of the original mass either in the as-received condition or in the dry condition as required.

31. Absorption of liquid

31.1 *Principle*

The method detailed here is an indirect method based on the weight of liquid absorbed by the film, the volume increase due to the liquid absorbed being calculated using the density of the film and of the liquid.

31.2 *Apparatus*

- Knife-edged punch or template with a sharp knife or razor capable of cutting squares of the film approximately 50 mm × 50 mm;
- balance with an accuracy of 0.1 mg;

- oven, capable of controlling the temperature to within ± 1 °C of the required test temperature specified in IEC Publication 674-3;
- circular glass dish at least 100 mm in diameter and suitable glass cover;
- sheets of unglazed absorbent paper 0.1 mm to 0.15 mm thick, suitable for rapidly mopping liquid from the surface of the test specimens;
- weighing bottles;
- density bottle or pyknometer.

31.3 *Test specimens*

Three specimens are tested. Each test specimen consists of sufficient pieces of film 50 mm × 50 mm to provide a specimen of mass not less than 300 mg. In case of film less than 50 mm width the test specimen shall be a length of film not less than 300 mg.

31.4 *Procedure*

Place the glass dish containing a quantity of the impregnant liquid (depth 10 mm or more) in the oven at the required test temperature.

Determine the mass *(m)* of each of the three test specimens weighed to the nearest 0.1 mg, at a temperature of 23 ± 1 °C.

When the impregnant liquid has attained the test temperature, immerse the three weighed test specimens in the liquid so that the squares remain separate and note the time.

After the time specified in IEC Publication 674-3, remove the test specimens from the oven and immediately place the test squares separately between sheets of the absorbent paper to mop the liquid from both surfaces, wipe them rapidly, thoroughly and firmly several times on both surfaces with clean pieces of paper and weigh the test specimens at room temperature (m_0).

Wiping and weighing should be completed within 15 min* of removal of the test specimens from the oven.

Measure the density of the plastic film (d) at 23 ± 1 °C by the method described in Clause 4.

Measure the density (d_1) of the liquid at 23 ± 1 °C using the density bottle.

31.5 *Calculations*

The absorption of liquid expressed as a percentage is:

$$100 \frac{(m_0 - m)}{m} \times \frac{d}{d_1}$$

31.6 *Result*

The absorption of liquid is the central value of the three determinations.

32. **Ionic impurities**

To be determined in accordance with IEC Publication 589.

* Since some impregnant liquids have some volatility at room temperature, this time should not be exceeded.

Principle

The presence of ionizable soluble organic and/or inorganic materials is determined by the increase in volume conductivity of the liquid extract.

33. Effect of insulating varnishes

33.1 *Procedure*

The following properties of the film are determined before and after immersion in the liquid:

- appearance, for example flatness, clarity, and colour;
- thickness (central value of one measurement taken at the centre of each of five 50 mm × 50 mm test specimens);
- tensile strength and elongation at break (central value of five results in the machine direction).

Sufficient ready-for-use insulating varnish is put into a suitable glass container which is closed and heated, for example in a liquid bath or hot cabinet to the temperature agreed for the particular varnish.

As soon as the insulating varnish has reached this temperature five test specimens are suspended in the varnish so that they are completely surrounded by the varnish and are not in contact with each other or with the walls of the container. The container is then closed again. After a time of 4 h ± 15 min at the agreed temperature the test specimens are removed separately from the container, rinsed for a few seconds in the varnish solvent and dabbed with filter paper. The rinsing and dabbing operations should not last longer than 60 s. The initial measurements are repeated and completed within 3 min of removal from the container.

33.2 *Results*

A comparison of the test results after immersion in varnish determines what changes have occurred. These changes shall be stated as the test result together with the insulating varnish used, these being:

- change in appearance, for example in flatness, clarity and colour;
- change in thickness in per cent (central value);
- change in tensile strength in per cent (central value);
- change in elongation at break in per cent (central value).

34. Effect of polymerisable resinous compounds in a liquid state

34.1 The effect of polymerisable resinous compounds in the liquid state is determined according to Sub-clause 33.1.

The temperature and duration of immersion in the polymerisable resinous compound depends on the nature of the compound used; immersion should not be longer than 4 h. The test specimens are removed for testing after the agreed time, but not later than the point at which gelation of the compound occurs. They are rinsed for a few seconds in toluene.

34.2 *Results*

The results of tests are evaluated according to Sub-clause 33.2. The temperature and time of the immersion in the polymerisable resinous compound shall be stated in the test report.

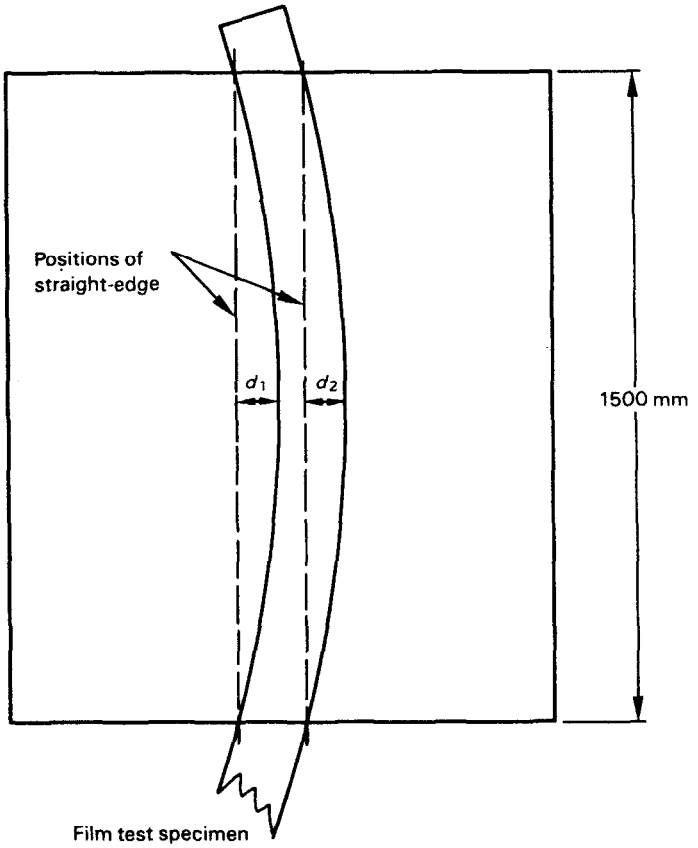


FIG. 1. — **Windability of film. Measurement of bias/camber; Method A.**
Plan view of measuring table:
d_1, d_2 = deviations of film edges at mid-span (the bias/camber is $d_1 + d_2$).

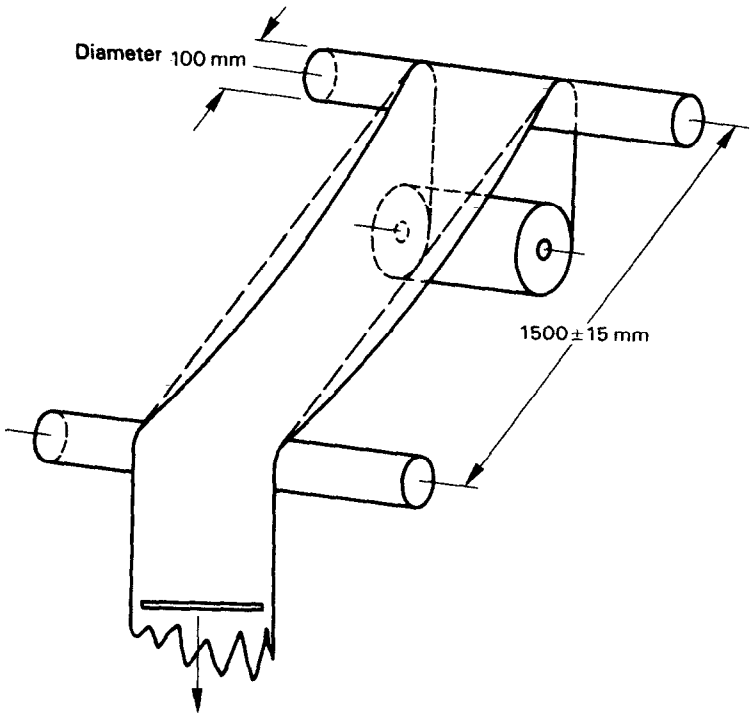


FIG. 2. — **Windability of film.**
Apparatus for measurement of sag; Method A.

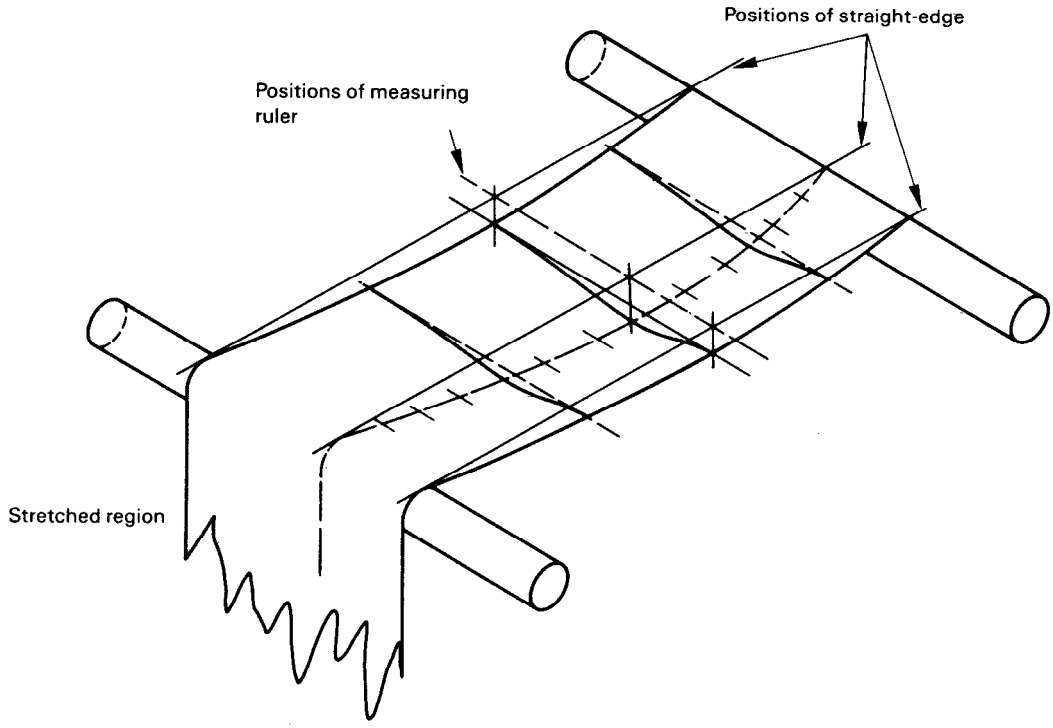
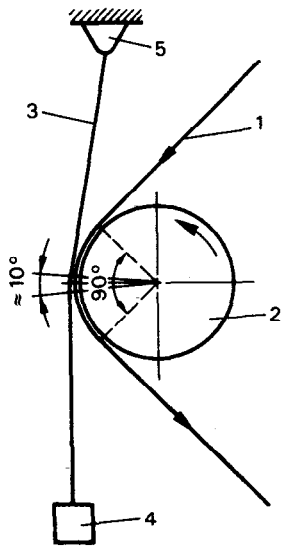
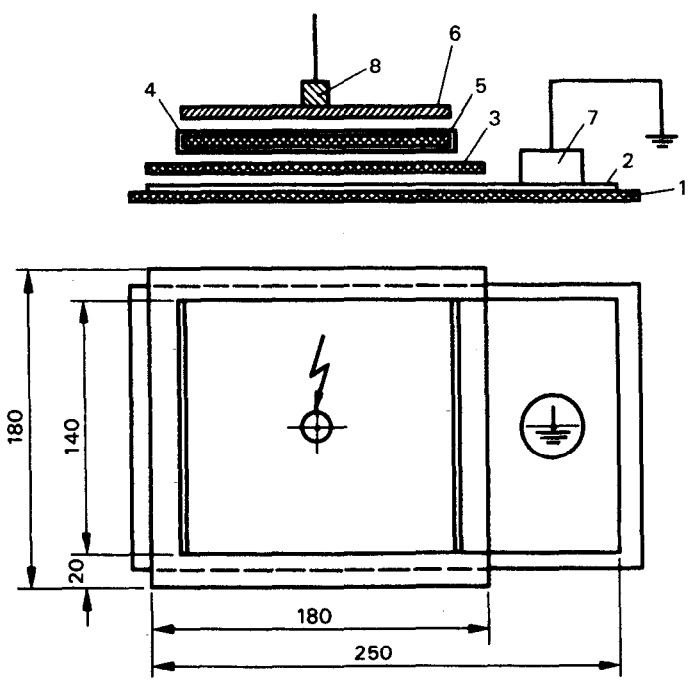


FIG. 3. — Windability of film.
Measurement of sag; Method A.



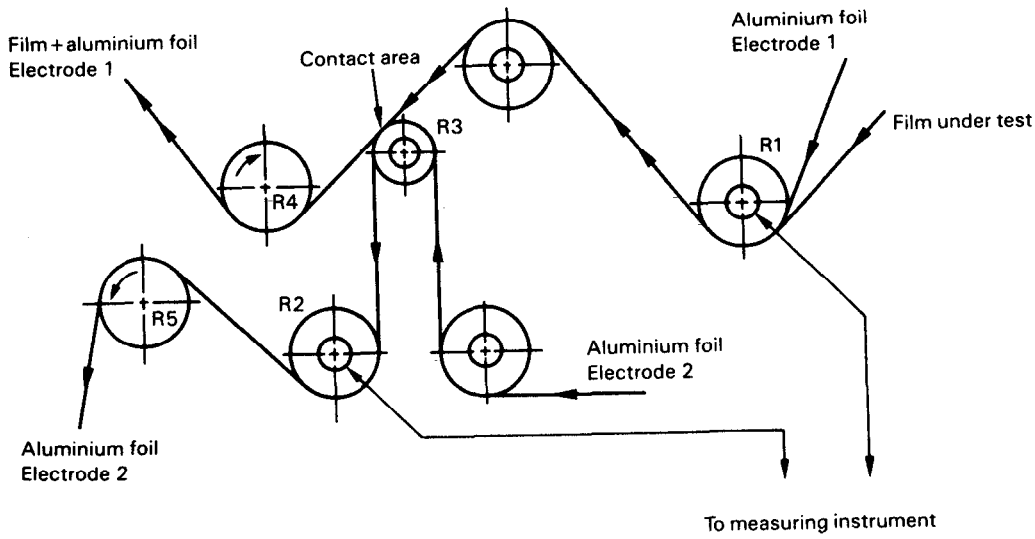
1 = specimen (strip of film)
2 = roller
3 = aluminium foil (strip)
4 = weight
5 = clamping device

FIG. 4. — Equipment for testing for electrical faults by Method A.



1 = insulating material
2 = plastic film with metal coating
3 = specimen
4 = plastic film with metal coating
5 = soft rubber
6 = metal plate
7 = contact piece
8 = connection for test voltage

FIG. 5. — Equipment for testing for electrical faults by Method B.



R1, R2 = contact rollers (metal)

R3 = measuring roller (quartz)

R4, R5 = drive rollers (rubber)

FIG. 6. — Equipment for testing for electrical weak spots by method C.

CORRIGENDUM

Page 15

25 Dimensional stability under pressure with rising temperature

25.3 *Procedure*

Replace the existing third sentence by the new sentence as follows:

Starting from 30 °C, the temperature is increased uniformly at a rate of 50 °C ± 3 °C per hour until the signalling instrument indicates the destruction of the specimen.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act,* 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards : Monthly Additions'.

This Indian Standard has been developed from Doc : No. ET 02 (3697).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 323 01 31, 323 94 02, 323 33 75

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices:	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	323 76 17, 323 38 41
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	337 84 99, 337 85 61, 337 86 26, 337 86 62
Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022	60 38 43, 60 20 25
Southern : C. I. T. Campus, IV Cross Road, CHENNAI 600113	235 02 16, 235 04 42, 235 15 19, 235 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093	832 92 95, 832 78 58, 832 78 91, 832 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PATNA. PUNE. THIRUVANANTHAPURAM.

Printed at New India Printing Press, Khurja, India